Space Weather Technical Forecast

Issued on Saturday, 01 October 2022 at 01:13 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: G1-G2/Minor-Moderate geomagnetic storms expected days 1 and 2. Chance of G3/Strong storm from CME arrival day 1. M-class flares considered Likely. Active electron fluence likely by day 3.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Moderate over the last 24 hours, with a M2.9 flare observed at 30/1622 UTC, which appears to have originated from AR3112, which continues to rotate into view from around the northeast limb. This has been the source of several CME's over recent days and is expected to be the most active region on the disc in the coming days. There are currently six numbered sunspots on the visible disc.

The largest and most active region appears to be the newly numbered region AR3112 that is currently rotating around the northeast limb, although this remains difficult to analyse due to foreshortening. AR3110 is now considered to be two separate regions, with a newly numbered AR3113 situated to the east of aforementioned region. AR3113 looks magnetically complex, with consolidation in its leading spot, and further trailing spots also emerging. AR3111 also in the northeast remains relatively simple, although some small spots/pores have occasionally emerged/faded around the periphery of the main penumbra. AR3107 and AR3105 in the southwest quadrant continue to show signs of decay, both remain simple and stable.

Solar Wind / Geomagnetic Activity: Solar wind parameters were indicative of continued high speed stream influence, with an embedded transient. Solar wind speeds, as measured by DSCOVR at L1, have been mostly at elevated levels, with a peak of 600 km/s around 30/0600 UTC. Density was generally around average to slightly above average, with a peak of 16ppcc. The total Interplanetary magnetic field strength, Bt, started weak, then became moderate after 30/0430 UTC, reaching a maximum of 15nT. The north-south component, Bz, was weak initially, then increased after 30/0430 UTC with periods in the negative orientation, fluctuating between +7/-8nT. The phi angle was mostly positive (away from the Sun) with brief periods at negative (towards the sun).Geomagnetic activity was Unsettled to Active (Kp 3-4) initially, becoming Quiet (Kp 1-2) by the end of the period.

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) as measured at GOES16, was near or at background levels. High energy electron flux (greater than 2 MeV) was at background levels. The associated 24-hour fluence remained below the Active (1e8 integrated pfu) threshold. Observed fluence at 01/0000UTC was 1.24e6 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is forecast to be Low, probably increasing to Moderate, with isolated M-class flares considered likely.

Solar Wind / Geomagnetic Activity: The CME from the filament eruption on 28/0400 UTC has the potential to move across Earth day 1 (1st). Solar winds are expected to remain elevated or

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slightly elevated at first, due to a high speed stream (HSS) from CH27/+, before the next HSS arrives from CH28/+ on day 1 (1st Oct). The HSS from CH28/+ may be combined with the arrival of a CME, which left the Sun on the 28th. HSS influence is expected to persist through days 1 to 3 (1st to 3rd), before waning on day 4 (4th).

Geomagnetic activity will be Quiet (Kp 0-2) initially, before increasing to Unsettled to Active (Kp 3-4) intervals early on day 1 (1st Oct). Activity is expected to become further enhanced due to the arrival of a HSS from CH27/+ and CH28/+, increasing to G1/Minor storm to G2/Moderate storm levels (Kp 5-6), with a chance of an isolated G3/Strong storm (Kp 7) interval, due to a possible combination of a HSS and CME, with the effects lasting into day 2 (2nd) and probably day 3 (3rd). Geomagnetic activity easing to Quiet to Unsettled (Kp 2-3) by day 4 (4th).

Energetic Particles / Solar Radiation: High energy (greater than 10 MeV) proton flux is expected to remain at or close to background levels. The high energy (greater than 2MeV) electron flux will likely remain at mostly background initially, but likely rising to exceed High (1000 pfu) levels at times, from day 2 (2nd) onward. However, there is some uncertainty due to the potential CME arrival tomorrow (1st), with any associated geomagnetic activity possibly offsetting the influence of the two HSS. The associated 24 hour fluence is likely to rise in response, and may exceed the Active (1e8 integrated flux) threshold later day 4 (3rd).

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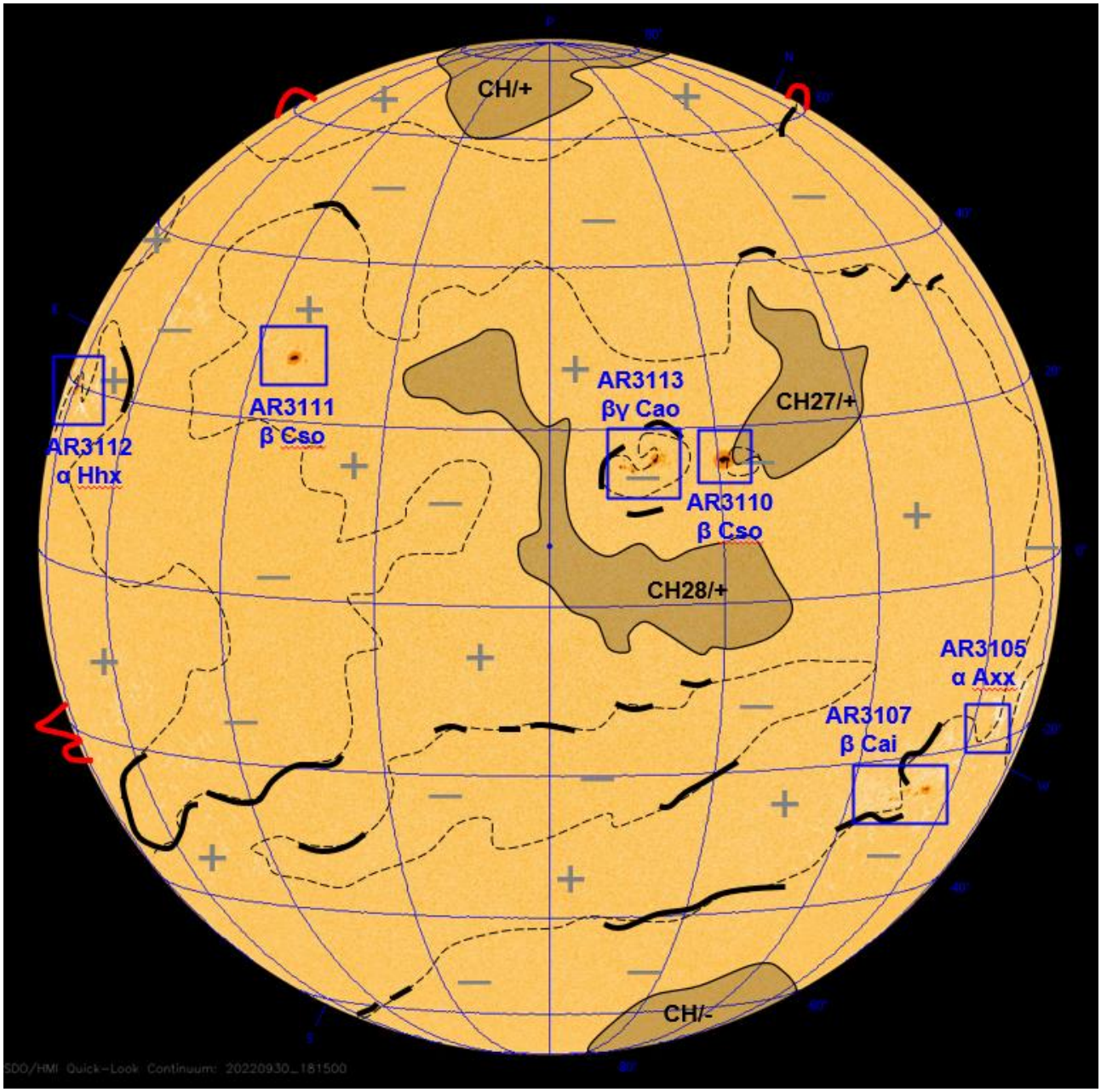
Figure 1. Solar Analysis Valid 30/1815 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

A CME from a filament eruption to the southwest of AR3110 around 28/0400 UTC has the potential to arrive at Earth day 1 (1st). However this has a low confidence analysis due to the lack of STEREO A imagery, combined with low confidence in background winds in the current Enlil model.

Solar winds are currently elevated and on a slight decline. The next HSS enhancements are expected to become geoeffective through day 1 (1st Oct), then persisting through the rest of the forecast period. These next enhancements are due to recurrent CH27/+ and CH28/+ which brought an extended period of Minor to Moderate geomagnetic storming on the last rotation (Kp 5-6). Similar activity is considered likely on this occasion, especially as the autumn equinox has recently occurred. There is some uncertainty though due to Enlil suggesting a slower arrival of the HSS influence, and Stereo A data, although patchy, currently shows little influence from either Coronal Hole. Solar winds are still expected to rise, with a peak of 600-700km/s on the arrival of either CH27/+ of CH28/+.

Geomagnetic activity will be Quiet (Kp 0-2) initially, before increasing to Unsettled to Active (Kp 3-4) intervals early on day 1 (1st Oct). Activity is expected to become further enhanced due to the arrival of a HSS from CH27/+ and CH28/+, increasing to G1/Minor storm to G2/Moderate storm levels (Kp 5-6), with a chance of an isolated G3/Strong storm (Kp 7) interval, due to a possible combination of a HSS and CME on day 1 (1st Oct), with the effects lasting into days 2 and 3 (2nd and 3rd Oct). Geomagnetic activity easing to Quiet to Unsettled (Kp 2-3) by day 4 (4th).

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	80	70	30	10
Strong	G3	No	30	10	1	1
Severe	G4	No	5	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
28/0856	Partial	Filament Eruption	NE quadrant	810 km/s	01/1000 +/- 10 hours	Likely embedded in HSS, Low confidence

Figure 2: ENLIL model (top) showing possible CME arrival on day 1 (1st Oct). Ensemble (bottom) shows uncertainty in the timing of arrival. Low confidence.

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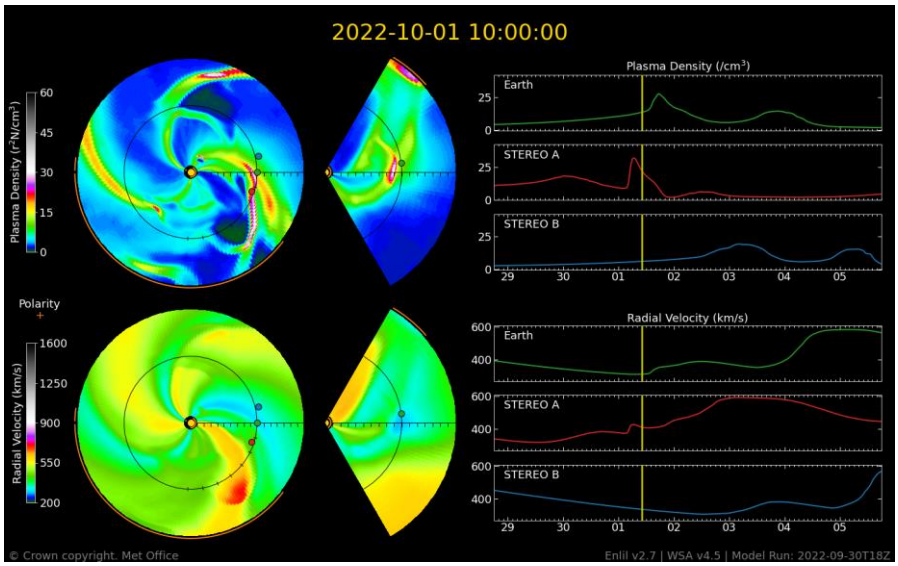

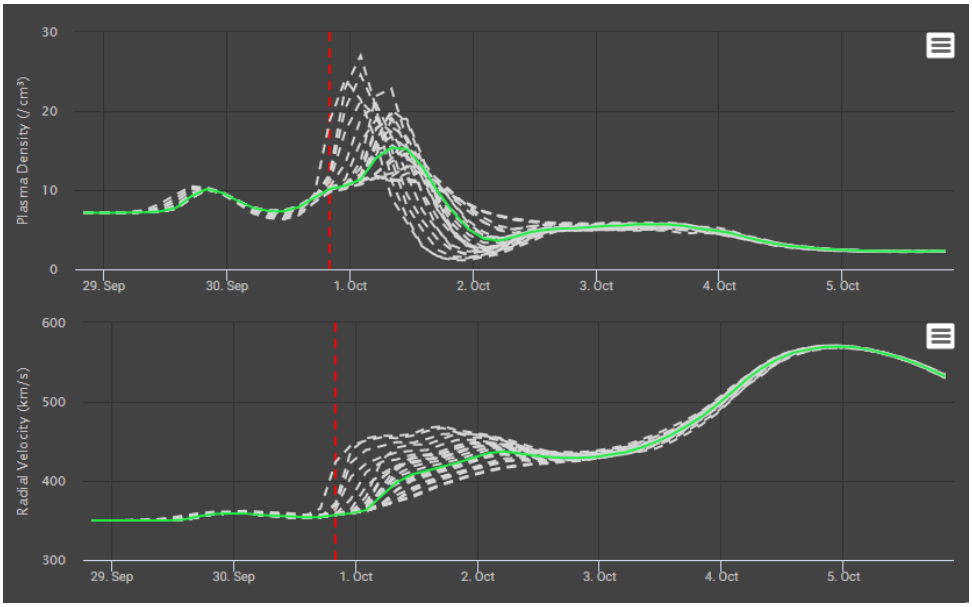

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Radio Blackouts - X-Ray Flares:
Solar activity has been Moderate in the last 24 hours, with a couple of M-class flares, peaking at M2.9 at 30/1622 UTC, originating from AR3112 rotating from around the northeast limb. Further isolated M-class flares are considered likely, mainly due to AR3112 in the northeast, but also combined with a risk from AR3113/Beta-Gamma.

There are currently six numbered sunspots on the Earth-facing disc. The largest and most active region appears to be the newly numbered region AR3112 that is currently rotating onto the northeast quadrant of the disc, although this remains difficult to analyse due to foreshortening. AR3110 is now considered to be two separate regions, with a newly numbered AR3113 situated to the east of aforementioned region. AR3113 looks magnetically complex, with a Beta-Gamma configuration. AR3111 also in the northeast remains relatively simple, although some small spots/pores are occasionally emerging around the periphery of the penumbra. AR3107 and AR3105 in the southwest quadrant continue to show signs of decay, both remain simple and stable.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	40	60	60	60
Very Active	R3 to R5 X Class	No	5	5	5	5

Figure 3: GOES-16 X-Ray Flares.

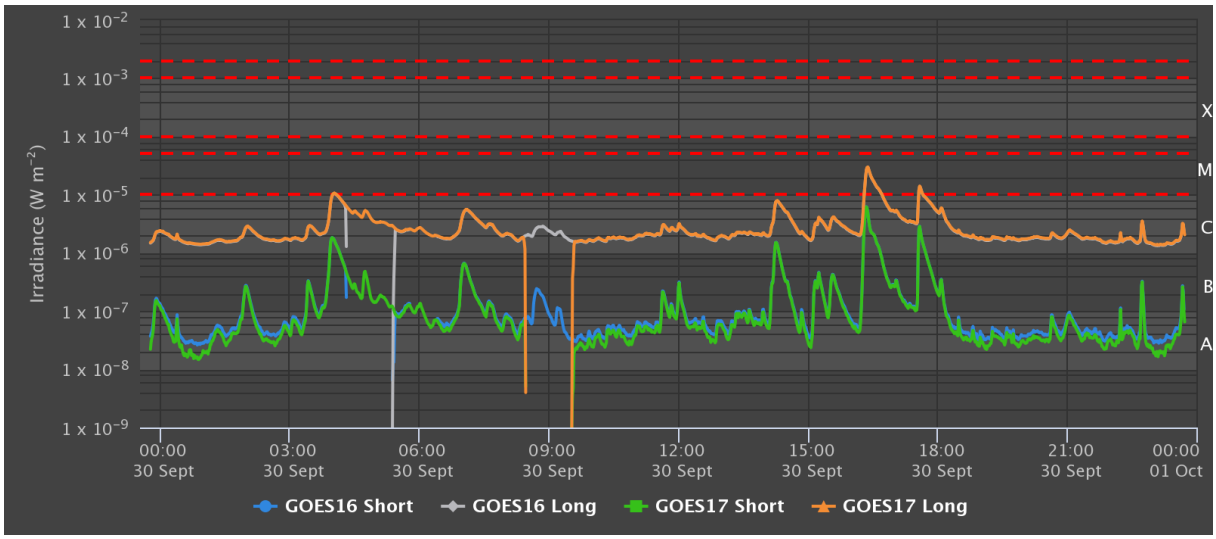

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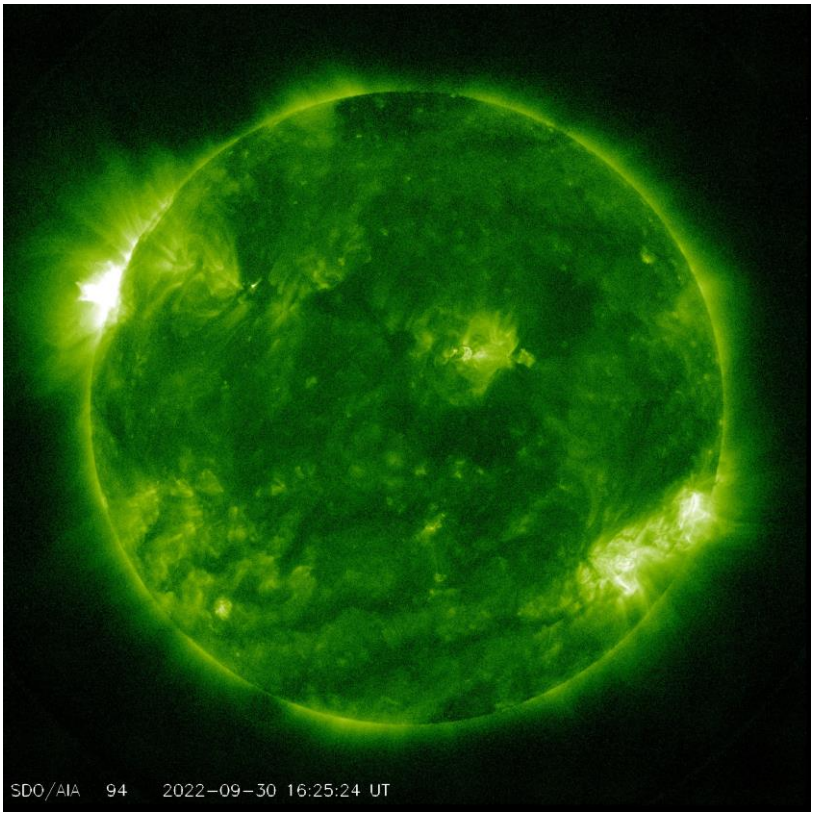
Figure 4: SDO/AIA 94 shows the M2.9 flare originating from AR3112 in the northeast.



Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (greater than 10MeV) as observed by GOES16 has declined from slightly elevated levels to near background. While AR3107, AR3110 and AR3113 move into an increasingly geoeffective location for proton events, there is only a very slight chance of rising to slightly above background levels.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	2	2	2	2
Very Active	**≥ S3 ***	No	1	1	1	1

* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)

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High Energy Electrons Event (≥ 2MeV):

The high energy (greater than 2MeV) electron flux, as observed by GOES-16 has been largely at background levels. The next significant rise in high energy electrons is anticipated to be once the fast winds from CH27/+ and CH28/+ become established, most likely from day 2 (2nd). However, building electron counts will be complicated by the potential CME arrival tomorrow (1st Oct). Further geomagnetic enhancements from a CME arrival would help to suppress high electron flux levels. and therefore peak values of over 10000 pfu may not occur until day 3 (3rd). The associated electron 24 hour fluence is expected to remain below the Active (1e8 integrated pfu) threshold until at least day 3 (3rd), while on a generally increasing trend. The REFM is currently over-estimating fluence values, which does not aid confidence in the fluence rising above the Active threshold by late day 2 (2nd). Instead a potential rise in the fluence to breach the Active threshold is preferred for days 3 and 4.

GEO Electron Environment	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ $1x10^{8}$	No	20	40	60	80
Very Active	≥ 2 MeV ≥ $1x10^{9}$	No	1	1	1	2

Figure 5:

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